SHALBATANA VALLIS: A POTENTIAL SITE FOR ANCIENT GROUND WATER. Ronald Greeley[1] and Ruslan Kuzmin[2], [1] Arizona State University, Dept. of Geology, Box 871404, Tempe, AZ 85287-1404, [2] Vernadsky Institute, Russian Academy of Sciences, Kosygin St. 19, Moscow, 117975, GSP-1 Russia.

Introduction: Within current mission constraints, most potential ancient ground water settings are found in the area between western Lunae Planum and western Arabia Terra. The geologic history of this area has significant implications for understanding Mars' hydrologic and climate history. Large collapse depression (chasmas), chaotic terrain, and multiple outflow channels are concentrated in the area. The formation of these features involves the influence of tectonomagmatic activity which are thought to have occurred during and immediately following the uplift of the Tharsis area early in Mars' geologic history [1-4]. The hydrological regime in the area is interpreted to include charging the ground water system by juvenile water and the release of water by melting of ice in the megaregolith [5]. Shalbatana Vallis is selected for detail study to assess their potential as landing sites for the exploration of ancient underground water systems.

General geology: Shalbatana Vallis is one of the narrowest (10-50 km cross) and deepest (as much as 3 km deep) channels in the Lunae Planum-Xanthe Terra area. Similar to other outflow channels, it originates in chaotic terrain within a circular depression 120 km in diameter. The channel trends NE down the general slope of Xanthe Terra and cuts through one of the oldest units of the highland terrain (unit Npl_2).

The channel is unusual because it appears to represent a single outflow initiated by a large impact. This impact could have excavated materials from the Martian crust from depths of several kilometers, apparently "tapping" the aquifer system leading to catastrophic flooding to form the channel. Ejecta from the Noachian impact crater [6, 7] is preserved NW-W and SE from the source area. The width of Shalbatana Vallis near its source is about 50 km and then it continues 500 km NE as a sinuous, narrow channel of nearly constant width (10 -20 km cross) and depth (~2 km). The channel then becomes wider (40-50 km), bifurcates, and enters Simud Vallis [7].

Mapping by Scott and Tanaka [6] and Rotto and Tanaka [7] suggests that Shalbatana Vallis drained a ground water system primarily during Hesperian times and could have continued activity into the Early Amazonian Epoch. The walls of the channel are cut into materials of Hesperian age and Noachian rocks of the plateau sequence, possibly including megaregolith [6].

Shalbatana Site 1: This site is in the NE part of the Shalbatana Vallis source depression on smooth plains between the inner cliff of the depression and the chaotic terrain. Sample targets include materials which were in contact with the inferred ancient ground water system: 1) ancient highland crust, 2) ancient impact breccias (megaregolith), 3) products from potential hydrothermal activity resulting from the interaction of ground water with impact melt, and 4) sediments associated with the outflow and seepage of ground water from the depression walls. In addition, samples of windblown deposits would provide information on modern aeolian and weathering processes.

Shalbatana Site 2: This site is near the SE base of the Shalbatana wall near the outlet from the source depression. It is on channel floor deposits and could afford sampling the same rock as from Site 1, but which was transported downstream by channel flow. Also included are materials from Shalbatana Vallis (unit AHchl), suggested to be young outflow channel sediments [7]. East of the site are deposits derived from mass wasting and slope failure of the channel walls derived from ancient plateau materials (unit Npl2), which could represent some of the earliest resurfacing processes in the highlands. Sampling Noachian rocks and younger channel materials (unit AHchl of Hesperian-Amazonian age) is important for addressing the early climate history and the hydrological regime.

Scientific rationale: The potential landing sites associated with Shalbatana Vallis include a suite of rocks and sediments that are accessible to sampling by a rover. Materials include: 1) the oldest stratigraphic sequence of Noachian highland plateau materials, including ancient impact breccias, and 2) Hesperian-age materials derived from outflow of ground water from the source depression. These rocks and sediments may contain geochemical signatures of the early Mars ground water ecosystem and climatic conditions. In addition, samples of modern aeolian sediments could provide information on more recent surface processes.

The location of the channel source within the large impact crater affords the potential to sample hydrothermally-altered materials resulting from the interaction of impact melt with ground water. This material could provide geochemical information on hydrothermal systems that have been modified by impact processes, which might have been widespread in early Mars history.

Carr [8] suggested that the evolution of Shalbatana Vallis is closely connected with the hydrological regime of Ganges Chasma. For example, shallow depressions with channel-like and collapsed features are found between the Shalbatana Vallis source area and the northern edge of Ganges Chasma. This relationship might reflect ground water drainage from a paleolake in Ganges Chasma into the source area of Shalbatana Vallis.

A key issue in the evolution of Shalbatana Vallis is to determine when water was released to form the

channel. Although the impact inferred to have initiated the process is mapped as Noachian [6, 7], superposition of its ejecta on younger channel deposits (unit Hchh) and the smooth unit of the plateau sequence (unit Hpl_3) suggests that the crater formed during the Hesperian. Mapping these and other relationships may constrain models of when ground water discharge occurred.

The different ages for the channel-branches of Shalbatana Vallis and their relations with units of the plateau sequence suggest a complex hydrological regime in Xanthe Terra. Detailed investigations of this area as part of landing site studies will lead to a better understanding of the sequence and potential magnitude of the ground water system.

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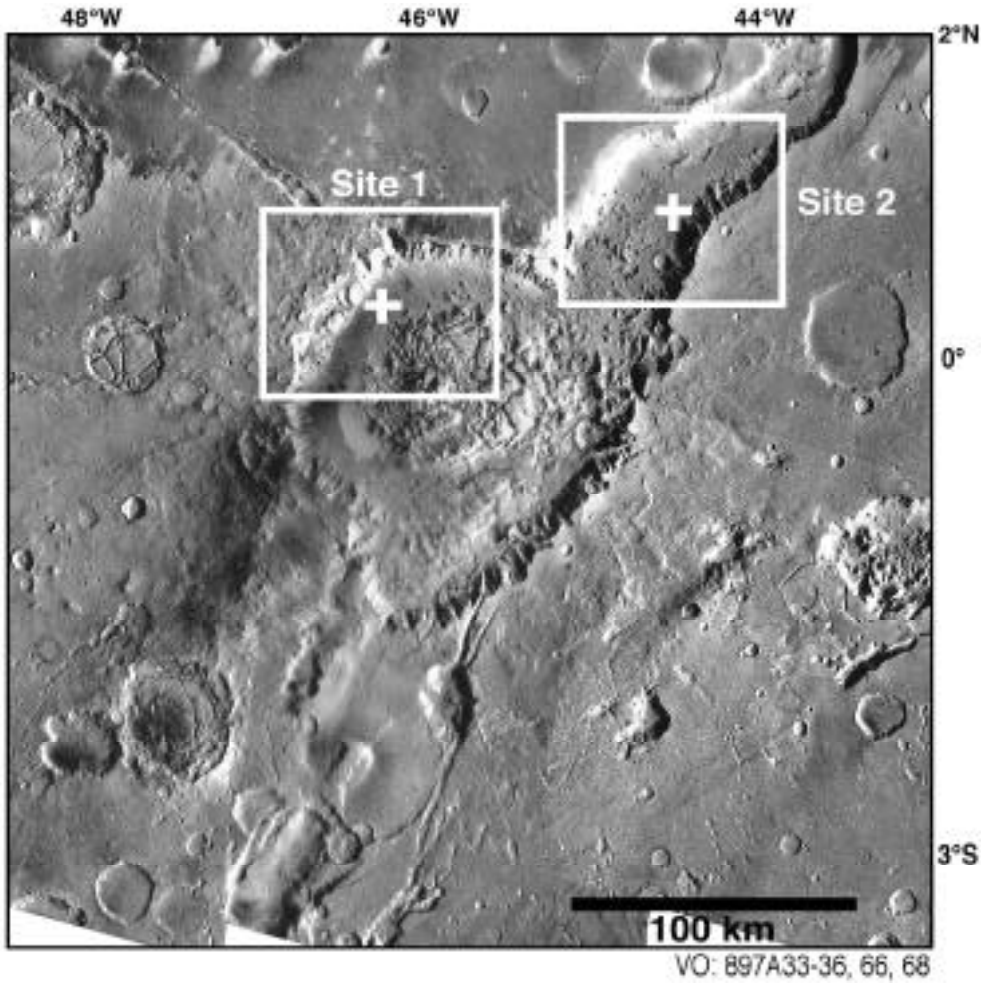

Viking Orbiter mosaic of Shalbatana Vallis. The landing sites are located at 0.2°N, 46.3°W, 0 to +1 km, and 0.7°N, 44.5°W, 0 to –1 km.